U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-293 536

Survey of Gasoline Tank Trucks and Rail Cars

(U.S.) Pacific Environmental Services, Inc, Santa Monica, CA

Prepared for

Environmental Protection Agency, Research Triangle Park, NC Emission Standards and Engineering Div

Mar 79

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EPA-450/3-79-004
March 1979

Air

PB 293536

EPA

Survey of Gasoline Tank Trucks and Rail Cars

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TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO. PB293536
4. TITLE AND SUBTITLE Survey of Gasoline Tank Trucks and Rail Cars		5. REPORT DATE March 1979 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) J. C. Hang and R. R. Sakaida		8. PERFORMING ORGANIZATION REPORT NO. EPA-450/3-79-004
9. PERFORMING ORGANIZATION NAME AND ADDRESS Pacific Environmental Services, Inc. 1930 14th Street Santa Monica, California 90404		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-02-2606, Task 20
12. SPONSORING AGENCY NAME AND ADDRESS U. S. Environmental Protection Agency Office of Air Quality Planning and Standards Emission Standards and Engineering Division Research Triangle Park, North Carolina 27711		13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

EPA Project Officer: Stephen A. Shedd

16. ABSTRACT

This informational document provides the basic and current use of tank trucks and rail cars in the gasoline marketing industry. Information contained in this document includes population, type and age of equipment, industry trends and costs for retrofitting existing vehicles to bottom loading and/or vapor recovery.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Volatile Organic Compounds Gasoline Marketing Rail Cars Tank Trucks	Air Pollution Control Mobile Sources	

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Unlimited	Unclassified	48
	20. SECURITY CLASS *(This page)*	22. PRICE
	Unclassified	PC A03/MF A01

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

EPA-450/3-79-004

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Contract No.68-02-2606

Task No. 20

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Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

March 1979

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SUMMARY

Tank vehicles and rail cars used in the gasoline marketing industry were briefly surveyed. Data were obtained from relevant trade associations and journals, equipment and tank manufacturers, tank operators, and the U.S. Bureau of Census.

Based on available information, there are currently an estimated 85,000 tank vehicles in gasoline service. Of these, about 26,500 are tank trucks and 58,500 are tank trailers.

Over 200 contacts, mostly by telephone, were made with those presumed to have knowledge concerning tank vehicles used in gasoline marketing. Descriptions of tank vehicles, population data, equipment, retrofit requirement for vapor recovery and cost data were obtained from these sources and are provided.

Information on loading methods and the presence or absence of vapor recovery systems was gathered for approximately 1,900 tank vehicles. More than 50 percent of tanks owned by these respondents contained or had been retrofitted with vapor recovery systems and bottom loading.

Very little information was available with respect to tank cars in gasoline service. Tank cars are, apparently, not used in dedicated service, and vapor collection systems are not common.

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1.0 INTRODUCTION

1.1 SCOPE

In gasoline marketing operations, most of the gasoline is transported between the terminal, bulk plant, and service station by tank vehicles. A small portion of gasoline is transferred by rail car. Up to the present time, transport of gasoline had not been specifically addressed with respect to types, equipment, and population of gasoline tank vehicles and rail cars. Such data were found to be of importance to the Emission Standards and Engineering Division (ESED) of the U.S. Environmental Protection Agency (EPA) in their current investigation of hydrocarbon and benzene emissions from gasoline marketing operations.

A survey was, therefore, conducted to gather information regarding the current population of gasoline delivery tanks (both tank vehicles and rail cars), the ages and types of tanks currently in service, industry trends, requirements for retrofitting existing vehicles with vapor collection systems, and costs required for retrofitting existing vehicles. It is expected that the data presented will be useful in the preparation of future standards and guideline documents for benzene and other volatile organic compounds. Aircraft refuelers and tanks transporting materials other than gasoline were not included in this study.

1.2 GASOLINE DISTRIBUTION

An overview of the tank vehicle industry and the types of truck operators are shown in Figure 1-1. The major distributors of gasoline are the "for-hire" carriers and the "private carriers." The "for-hire" carrier, which accounts for 28 percent of the gasoline delivery tanks, operates as a common or a contract carrier. This type of carrier transports products of manufacturers and

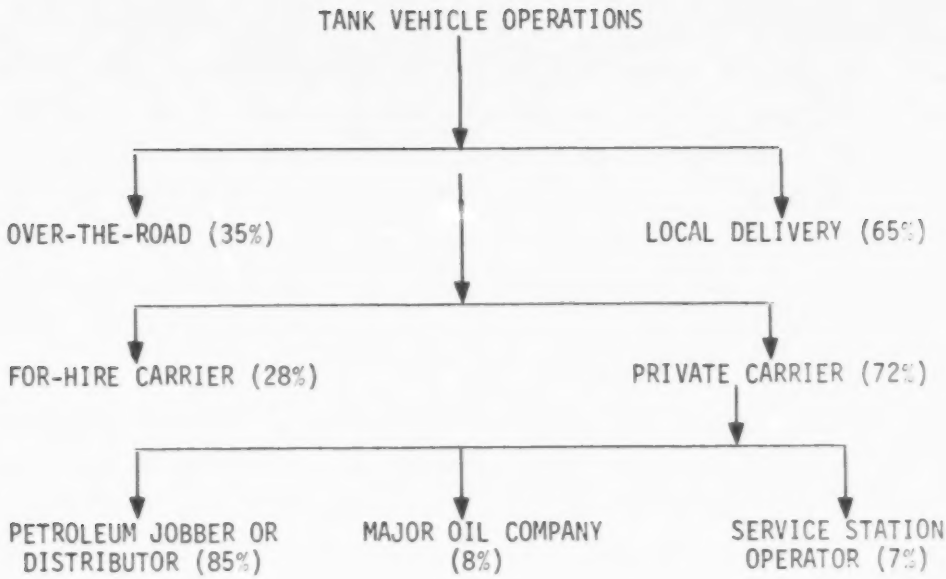


Figure 1-1. Petroleum Delivery Tank Vehicle Operations[1]

other shippers of liquid or dry bulk commodities. In other words, the "for-hire" carrier acquires its profit by hauling for others. The private carrier hauls its own products. These carriers and the percentage of gasoline delivery tanks operated are petroleum jobbers or distributors (61 percent), major oil companies (6 percent), and service station operators (5 percent).[1]

Gasoline distribution between terminals, bulk plants, and service stations can be divided into "over-the-road" and "local delivery" operations. "Over-the-road" is also known as the intercity type of operation. As the name implies, the tank vehicles operate between terminals and redistribution points. Both "for-hire" carriers and private carriers deliver gasoline over-the road. The types of tank vehicles employed are mainly semitrailers, semitrailer-full trailers, or straight truck-full trailer units. The latter two types are known as double bottom units.

"Local delivery" operation is engaged in local delivery of products from terminals or bulk plants to industrial consumers, homes, farms, and service stations. For small quantity deliveries, the types of tank vehicles employed are primarily straight trucks (Bob tail) or small semitrailers.

Practically all of the gasoline transported by delivery tank from a terminal or bulk plant to a bulk plant or service station is by tank vehicles. Less than 2 percent of bulk plants were stated to receive products by rail cars.[2] Much of the information gathered and presented in this report will thus be concerned with tank vehicles.

2.0 GASOLINE DELIVERY TANKS

2.1 DESCRIPTION

Gasoline tanks are generally built of aluminum alloys, although stainless steel is sometimes used. The advantage of an aluminum alloy tank is its lighter weight as compared to other materials. Aluminum tanks can haul more gallons at an equivalent gross vehicular weight which means fewer trips to haul the same amount of gasoline. These tanks, which range in size from 1,200 to 10,000 gallons, are usually divided into several compartments with different sizes to meet the operator's specific requirements. Thus, one delivery tank can carry several different grades of gasoline or several different products, if necessary.

Tank vehicles which operate between cities are usually equipped with hoses, several types of valves, and connections. It is reported that approximately two-thirds of the vehicles are equipped with pumps and more than one-third with meters.[3] The local delivery tanks are equipped with meters, valves, pumps, hoses, and hose reels.

The Modern Bulk Transporter[1] reports that the average vehicle life span is about 13 years for tanks or trailers, and 8 years for straight trucks. Major carriers will generally use tank vehicles for less than the average vehicle life span, and a small marketer may use them for longer than the average life span.

2.1.1 TANK VEHICLE NOMENCLATURE

Tank vehicles are classified into three types: straight truck (tank truck), semitrailer, and full trailer. A straight truck is a single self-propelled motor vehicle equipped with cargo tank. As a single unit, the straight truck is also known as a "Bob Tail" or "Body Load" truck.

Additional definitions of tank vehicles are as follows:

1. Semitrailer - Any vehicle equipped with a cargo tank that is drawn by a tractor by means of a fifth wheel connection. Some part of the semitrailer's weight and load rests upon the towing vehicle.

2. Full Trailer - Any vehicle equipped with a cargo tank and is constructed so that practically all of its weight and load rests on its own wheels.

3. Double Bottom Unit - A unit comprised of either a semitrailer or a straight truck and a full trailer. In this arrangement, the semitrailer or straight truck functions as the towing vehicle.

4. Tank Vehicle - Any tank truck, full trailer, or tractor and semitrailer combination.

2.1.2 TANK VEHICLE EQUIPMENT

Manholes, compartment markers, emergency valves (also called internal valves), and unloading adaptors are essential equipment for a typical top loading tank vehicle (Figure 2-1).

Manholes are installed on the top of each compartment. They function as a product inlet during top loading operation and provide entry for cleaning or repair. The manhole cover is fitted with pressure vacuum vents for normal venting requirements. Also, it is spring loaded and is used for emergency venting. In bottom loading systems, the cover is commonly used as positive back-up protection against tank rupture due to overfilling.

When the normal tank vent is mechanically operated, the vents are installed directly over the internal valves (within one-half inch[4]) to which they are mechanically interconnected. The vent then opens and closes in unison with the valve.

During a bottom loading operation, the internal valve is opened for product flow, and the vent is open to permit an exit for vapors which are displaced by the incoming product. The internal valve

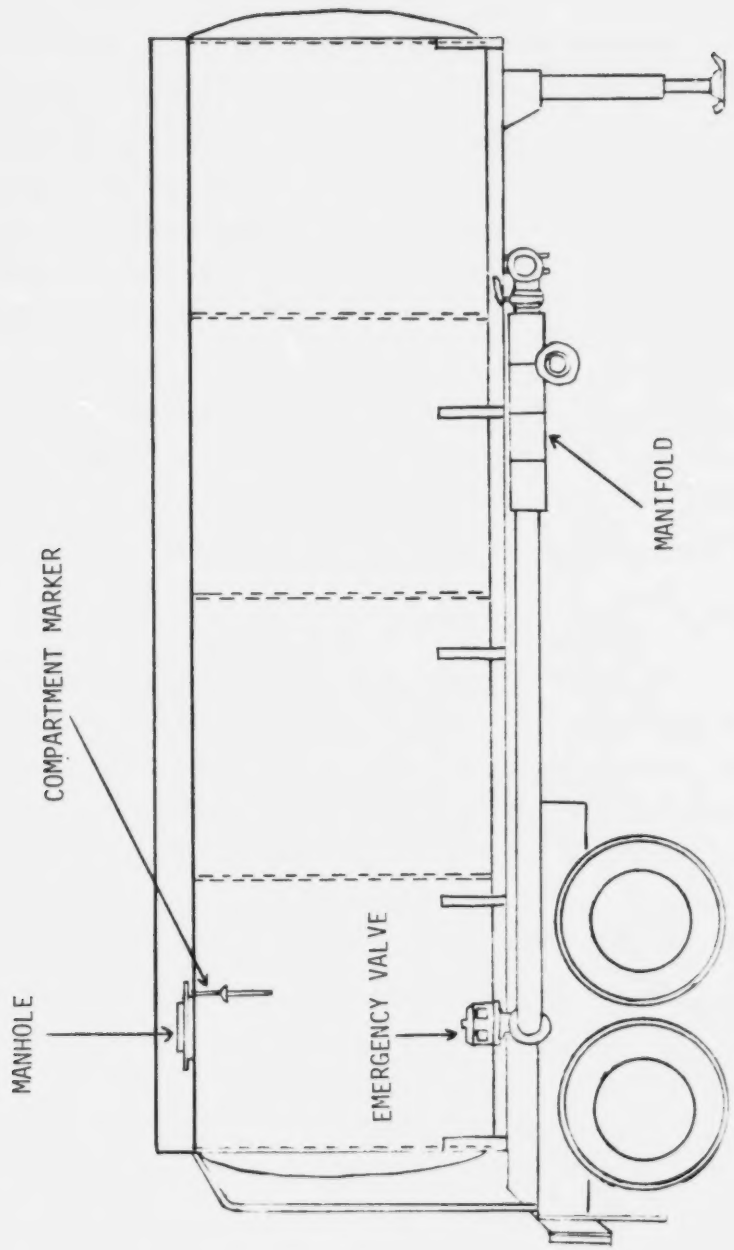


Figure 2-1. Top Loading Tank

and vent reopen to draw in air as the product leaves the tank during unloading. Many of these vents are air or hydraulically operated and normally located near the center of the compartment. These vents can be opened or closed independently of the internal valve.

The compartments can be unloaded through a manifold by one single adaptor when mixed products are allowed. Otherwise, a separate adaptor is installed on each compartment. A double bulkhead and a separate delivery system are required when compartments contain different classes of products. This would insure no mixing between compartments.

The liquid level in the compartment can be visually checked by a compartment marker. These markers are visible only from the top and cannot stop the flow of products. Thus, for bottom loading, secondary level control systems are required.

2.1.3 OVERFILL SHUT-OFF

The overfill shut-off devices function as a secondary level control system. It will automatically shut-off the incoming flow of products when the maximum allowable liquid level has been reached in the compartment. These devices prevent product overflow due to meter failure and incorrect meter setting by the operator.

2.1.4 TANK CARS

Very little information was available concerning the use of tank (rail) cars for gasoline service. However, less than 2 percent of bulk plants receive gasoline via rail cars[2], and other deliveries by tank cars are negligible in the gasoline marketing operations. Therefore, emissions from tank cars used in gasoline distribution were assumed to be insignificant.

Typically, tank cars used for gasoline delivery range from 10,000 to 20,000 gallons in capacity.[5] Tank cars are, however,

not normally used in dedicated service (i.e., products carried by tank cars normally vary from trip to trip). Therefore, the various sources contacted would not venture an estimate on the number of tank cars used in flammable liquid service but stated that the number would fluctuate substantially.

Tank cars are most commonly loaded through the manhole or through a closed loading system located on the top. Unloading is through the bottom fittings which are sometimes used for loading.

The Association of American Railroads also indicated that vapor collection systems are not commonly found on tank cars.[5]

2.2 TANK VEHICLE CATEGORIES

Tank vehicles are categorized in this document according to age, type and size, and method of loading (Table 2-1).

Table 2-1. TANK VEHICLE CATEGORIES

Age	
Pre - 1967	May not be economical to retrofit to bottom loading and/or vapor recovery
1967 - 1975	
1976 - 1979	Generally built with provisions for vapor recovery and bottom loading
Type and Size	
Single Unit Straight Trucks (also called body load or bob tail)	1,200 - 5,000 gal
Tank Semitrailers	5,000 -10,000 gal
Full Tank Trailers	4,000 - 7,000 gal
Loading Method	
Top Load	Top Tight Submerged
Bottom Load	

2.2.1 AGE OF TANK VEHICLES

Contacts with manufacturers of delivery tanks indicated a substantial number of tanks currently in service were built prior to 1967. In that year, either due to establishment of motor carrier regulations or other reasons, changes were made in tank construction. These changes permit the retrofit of tanks with bottom loading and/or vapor recovery systems without the higher costs required of the pre-1967 tanks.

Several of the problem areas with retrofitting the pre-1967 tanks include: a smaller manhole, free flowing vents, the use of single wall instead of double wall overturn protection rails, pressure-vacuum valves which do not meet current EPA requirements, 3-inch instead of 4-inch discharge line, and the construction of the tank which makes it difficult to install an internal/emergency valve.

Since 1976, most delivery tanks for flammable liquids have been built with provisions for bottom loading and vapor recovery. These include a taller double-walled overturn rail, which can be used as a conduit in addition to protecting the vapor recovery hoods. Specified sites are also designated for and blanked off for future installation of vents, hoods, vapor recovery lines, internal valves, and secondary shut-off systems. A few firms had incorporated these provisions into tanks fabricated since 1974.

Thus, the age category was divided into three periods: (1) for the pre-1967 tanks, difficulty may be encountered in retrofitting with vapor recovery; (2) for tanks built during 1967 to 1975, retrofitting can be done at some cost; and (3) in the post-1975 period, most tanks shipped had provisions for addition of vapor recovery and bottom loading without the need for cutting or welding of the tank.

2.2.2 TYPE/SIZE

The types of delivery vehicles employed in gasoline marketing operations are straight truck, semitrailer, and full trailer. Contacts with tank vehicle manufacturers indicated that ranges of capacities for each type of delivery tank were as follows: straight truck ranged from 1,200 to 5,000 gallons, semitrailer ranged from 5,000 to 10,000 gallons, and full trailer ranged from 4,000 to 7,000 gallons. The total capacity of delivery vehicles including double bottom units normally do not exceed 10,000 gallons.

2.2.3 LOADING TECHNIQUES

Delivery tanks can either be loaded from the top or the bottom of the tank according to the systems installed on the tank and at the loading rack. Tank and rack systems must be compatible.

2.2.3.1 Top Loading

Top loading is divided into open top, with and without vapor recovery, and top tight submerged fill. Open top involves loading of products into the compartment via the manhole which is located on top of the tank. Gasoline can be loaded directly into the compartment through a top loading head (splash fill). Attachment of a fixed or extensible downspout to the loading head provides a means of introducing the product near the bottom of the tank (submerged fill). A deflector at the outlet of the downspout provides for uniform spreading of the product and eliminates both static buildup and product splash.

In addition to submerged fill, the top loading head can be designed for vapor recovery. This top loading vapor head must be compatible with the truck hatch opening, and a vapor tight seal is required between the head and the hatch to minimize vapor leakage during transfer of product.

These top loading systems, which require opening of the hatch (Figure 2-1), must be equipped with a separate vapor recovery system for delivery to customers with vapor balance systems.

Provisions for top tight submerged fill have been installed in tank trucks primarily in Texas. This installation permits the loading of product through a vapor tight loading adaptor mounted on top of each compartment (Figure 2-2) and attached to a submerged fill pipe. For vapor recovery, the vapor spaces of each compartment are manifolded to the overturn rail or to a vapor return line.

One advantage of this permanently affixed top tight submerged fill is that the hatch/dome covers remain closed at all times except for clean up and repair. No vapor loss is, therefore, attributable to opening of the hatch. The top tight and vapor head system can collect vapors expelled from the tank during product loading.

2.2.3.2 Bottom Loading

Bottom loading permits the operator to stand on the ground for loading the tank through connectors at the side of the tank. Since the discharge opening of the tank is used for loading, submerged fill occurs naturally. Some of the advantages cited for bottom loading are: (1) improved safety, (2) faster loading, and (3) reduced labor costs. Off-loading and on-loading adaptors, a single valve for both in and out service or Y-valves, must be provided for individual compartment loading and unloading (Figure 2-3). Additionally, an emergency or internal valve is required as well as a vent valve when gasoline is being loaded. A means to prevent gasoline spraying into the tank must be included, and a liquid high level sensor is necessary for secondary automatic shut-off purposes. Tanks with bottom loading provisions can normally be top loaded from an open hatch.

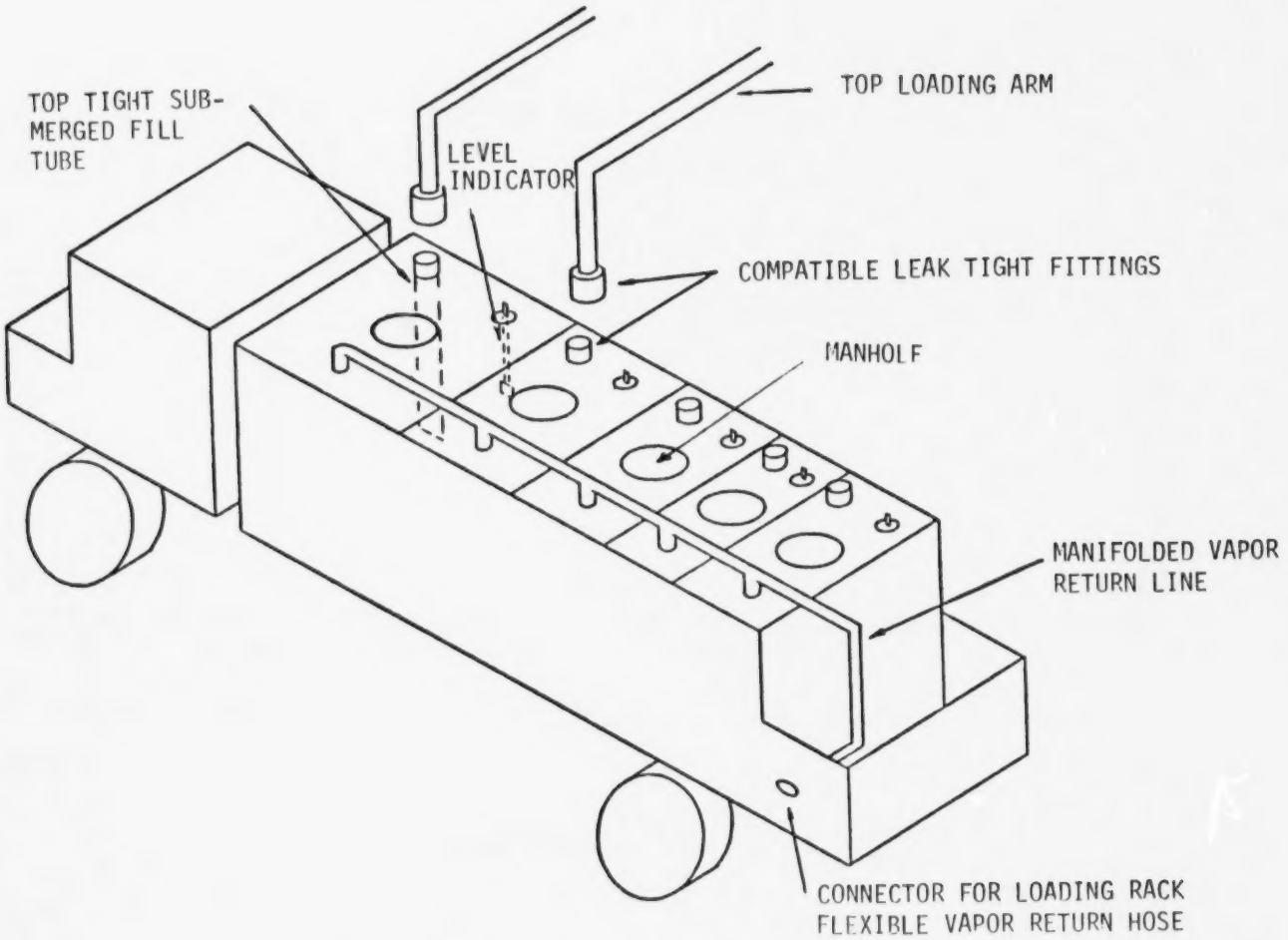


Figure 2-2. Top Tight Submerged Fill Tank

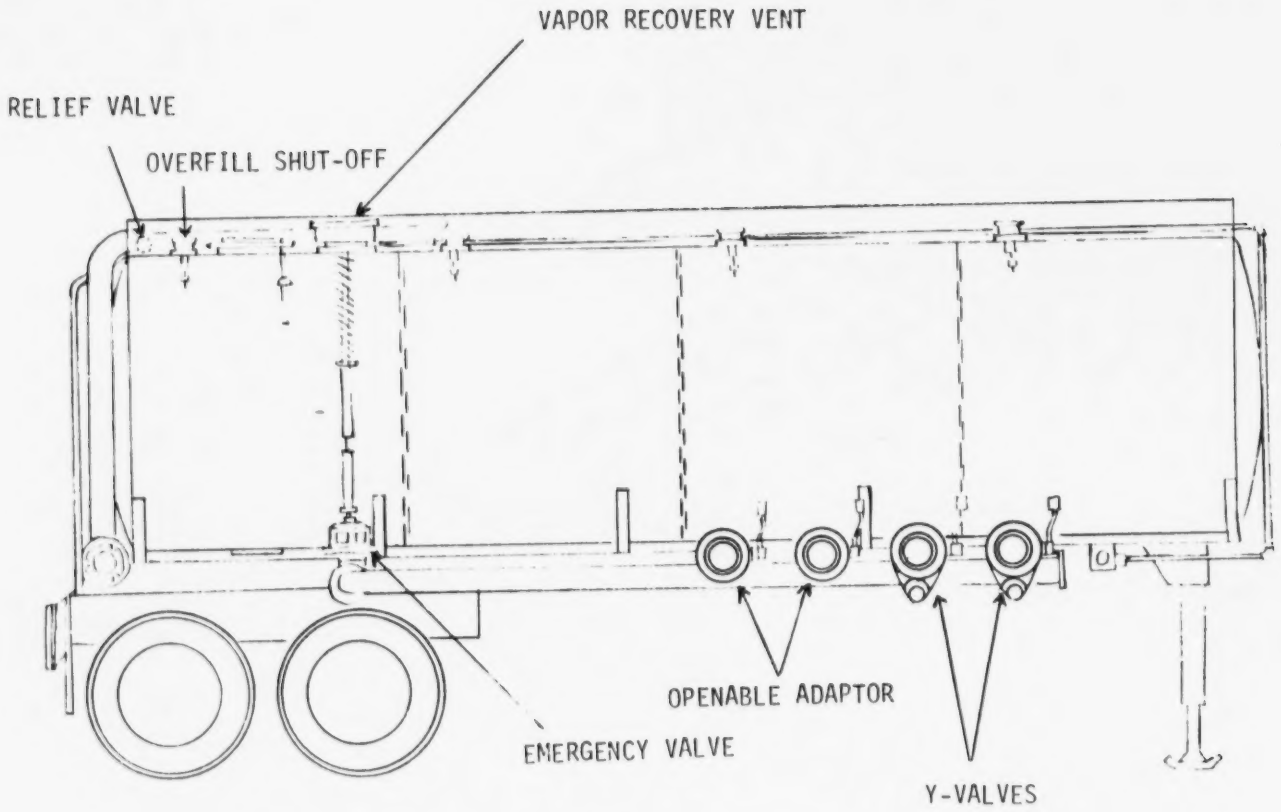


Figure 2-3. Bottom Loading Tank

2.3 POPULATION AND TRENDS

2.3.1 POPULATION ESTIMATES OF GASOLINE DELIVERY VEHICLES

On the basis of tabulations compiled by the Truck Trailer Manufacturers Association, there were 7,415 truck trailer tank shipments (tanks manufactured) for flammable liquids in 1976 and 1977; 26,280 tank shipments for the years 1967 through 1975; and 34,373 tank shipments for the years 1957 through 1966. The total shipment was 68,068 units during the 21 year period (Table 2-2). These data were originally obtained from the U.S. Bureau of Census' Current Industrial Reports. As a comparison, a total of 124,143 tank trailers for liquid service was shipped during the same period.

Table 2-2. GASOLINE TANK VEHICLE POPULATION ESTIMATE

Estimates From Several Sources	
Total tanks/liquid trailers in use[a]	131,920
Number in flammable liquid service[b] (excludes LPG, fuel oil, asphalt, etc.)	
Trailers (semi and full)	67,523
Tank trucks	30,295
Total	97,818
Trailer shipments[c] (all flammable liquids)	
1976 - 1977	7,415
1967 - 1975	26,280
1957 - 1966	34,373
1954 - 1956	16,113
Total (1954 - 1977)	84,181
Total (1957 - 1977)	68,068

[a] Commercial Car Journal, p. 138, June 1978

[b] Modern Bulk Transporter, "The 1978-1979 Tank Trucking Industry Market Report," Sutherland Publications, Inc., Washington, D.C.

[c] Truck Trailer Manufacturers Association, tabulated data from Current Industrial Reports of U.S. Bureau of Census, Washington, D.C.

According to the Commercial Car Journal, there are an estimated 131,920 liquid tank trailers in current use.[6] Based on information obtained from personnel at the Heil Company, approximately 55 percent of these trailers are used to deliver flammable liquids. This value (55 percent) is near the number which can be calculated from the tank trailer shipment data. Also, estimates were made that determine that the percentage of flammable tanks used in gasoline service ranged from 70 to 90 percent.[7,8] Taking an intermediate estimate of 80 percent of the flammable liquid tanks as being used for gasoline delivery, approximately 44 percent of the total 131,920 liquid tank trailers or 58,000 tank trailers are used for the delivery of gasoline.

Additionally, "The 1978-1979 Tank Trucking Industry Report"[1] estimates that a total of 97,818 tank vehicles are currently carrying flammable liquids (gasoline, etc.) excluding fuel oils and LPG. Of the total, 30,295 are straight trucks and 67,523 are trailers.

Using the current supply and demand figures for petroleum products,[9] and excluding those products for which a separate listing of delivery tanks was presented, approximately 87 percent of the delivery tanks listed under this source for flammable liquids are used in gasoline service. Estimated numbers are then 26,400 straight trucks and 58,700 trailers, which total 85,000 tank vehicles in gasoline service. In both approximations, the total number of trailers in gasoline service is estimated to be 58,000.

2.3.2 POPULATION OF RAIL TANK CARS

Of the many contacts made to gather information concerning rail cars, only the Association of American Railroads provided population data. There are approximately 100,000 - 111A tank cars of which a half or more is estimated to be in flammable liquid

service. The total number of cars fluctuates because flammable liquid cars are not in dedicated service.

2.4 TANK CATEGORIES AND QUANTITY ESTIMATES

2.4.1 AGE

Only gross estimates were made of the distribution of tank vehicles according to age. Data used included: (1) estimates of flammable tank vehicles in use of 97,800 for 1978[1] and 83,800 for 1974;[10] (2) the annual tank trailer shipments (Appendix Table A-1); and (3) the Bureau of Census' surveys of trucks and trailers for 1972 (Appendix, Table A-2).

Assuming a linear extrapolation of tank vehicles, there would have been some 75,000 tanks for flammable liquids use in 1972. The census data were used to estimate the number of tanks built prior to 1967 and during 1967 to 1972 by using ratios of surveyed tanks. Subsequently, tank losses of 20 and 10 percent were assumed for the pre-1967 and 1967 to 1972 tanks, respectively. This resulted in an estimate of 64,100 tanks built in and before 1972. The balance of 33,700 tanks was assumed proportionate to the trailer shipments for the periods 1973 through 1975 and 1976 through 1977 (Appendix A-3).

Taking 87 percent of these as being in gasoline service, then using these age distributions and the tank trailer shipment data as guidelines, the population distribution as a function of age was estimated. The results are shown in Table 2-3.

2.4.2 BODY TYPE

Telephone contacts were made with as many gasoline transporters as possible. Those from whom information was obtained and the data obtained are given in Table 2-4. Over 1,900 delivery tanks were accounted for in this brief survey. Although this number represents

Table 2-3. ESTIMATED POPULATION OF TANKS IN GASOLINE SERVICE AS A FUNCTION OF AGE[a]

A g e	Truck	Trailers	Total
1976 - 1977	5,000	7,000	12,000
1967 - 1975	20,500	23,000	43,500
Pre - 1967	1,000	28,500	29,500
Total	26,500	58,500	85,000

[a] These values are only intended as estimates.

only a small percentage of delivery tanks, it is assumed that distribution of tanks in the respective categories are representative of the whole. These values may be improved with additional data.

Descriptions of the pulling units were not generally available from the sources contacted. From the total capacity of the double bottom units and the capacity ranges of the tank types (Table 2-1), it was assumed that combinations, whose total capacity was 9,000 gallons or less, were pulled by straight trucks. This resulted in 182 straight trucks and 227 still unclassified pulling units. Taking the entire range of 182 to 409 pulling units as straight trucks, 17 to 29 percent of the surveyed tank vehicles are straight trucks, 27 percent are full trailers, and 44 to 56 percent are semitrailers.

2.4.3 LOADING METHOD

From the data obtained and given in Table 2-4, approximately 7.4 percent of tanks were specified as being bottom loaded only, although all tanks can be top loaded through the hatch. An additional 69.8 percent had top and bottom loading, 0.1 percent had top tight submergible loading, and 22.7 percent had only top loading. This distribution is subject to change with additional data.

Table 2-4. TANK VEHICLE SURVEY DATA

Company	Quantity		Size Range (gallons)	Age Range (year)	Loading Technique[c]				Bottom Load Adaptor[c]			Secondary Automatic Shut-off[c]				Vapor Recovery System[c]			Annual Gasoline Throughput (gallons)
									On Individual Line										
	Double Bottom Unit[a]	Single Unit[b]			Open Top	Sub-merged	Bottom	Top And Bottom	Y Valve	Open-able	On Manifold	Jet Level Sensor	Float Sensor	Dyne-Probe	None	Individual Compartment	Manifolded	None	
Acme Transport	6		9,000	1971 - 1978	6		6				6					10	2		
ADA Resources		3 (s)	8,000 - 8,500	1964 - 1977				3		3		3				3			
Aero Oil	30		2,500 - 8,000	1971 - 1978	60										60			60	
Aero Oil		8 (s)	7,000 - 8,000	1971 - 1978	8										8			8	
American Transfer	19				8		12									12		26	
Amospost		3 (s)	8,600	1975 - 1977	3										3			3	
Armour Oil	55		9,500	1964 - 1978				110								110			
Asbury System	100		9,000 - 10,000	1968 - 1978				200		200		200				60		140	
Atlantic Richfield		148 (s)	8,000	1971 & older - 1976	8			140					148				140	8	
Atlantic Richfield		55 (s)	9,000	1977 - 1978				55					55				55		
Atlantic Richfield		143 (b)	4,000	1972 - 1978				143					143				143		
Atlantic Richfield		103 (f)	5,000	1972 - 1978				103					103				103		
Augsburg Corporation		15 (s)	8,000 - 8,500	1967 - 1973			15		15			15						15	
Carlos R. Leffler		12 (s)	8,000 - 9,000	1970 - 1978	6		6		3	3			9	3		6		6	
C F Tank Lines	10		9,000	1968 - 1973	20										20			20	
Continental Oil	20		8,000	1975 - 1978				40											
Continental Oil		258 (s)	8,000	1975 - 1978				258											
Cook and Cooley	3		9,000	1973 - 1978	6										6		6		
Cook and Cooley		1 (s)	9,000	1973	1										1		1		
Crown Central Petroleum		10 (s)	7,000	1972 - 1976			10		10			10					10		
Cumberland Oil		2 (s)	9,200	1968 - 1976	1			1				1			1		1	1	0.5 MM - 1.5 MM
Cumberland Oil		1 (b)	2,000	1966	1										1			1	0.5 MM
Delta Oil		8 (s)	8,000	1973 - 1975			R				8				R	R			
Desert Oil		4 (s)	9,500 - 10,000	1966 - 1978				4		4					4			4	

Table 2-4. TANK VEHICLE SURVEY DATA (CONTINUED)

Company	Quantity		Size Range (gallons)	Age Range (year)	Loading Technique[c]				Bottom Load Adaptor[c]			Secondary Automatic Shut-off[c]				Vapor Recovery System[c]			Annual Gasoline Throughput (gallons)
	Double Bottom Unit[a]	Single Unit[b]			Open Top	Sub-merged	Bottom	Top And Bottom	On Individual Line: Y Valve	On Individual Line: Openable	On Manifold	Jet Level Sensor	Float Sensor	Dyna-probe	None	Individual Compartment	Manifolded	None	
Diamond Tank Lines	10		8,000 - 9,000	1963 - 1978				20	20			20					20		
Franko Oil	5		9,500	1963 - 1978				10								10			
Gasco Incorporated	7		9,000	1973 - 1977				14							14	14			5.0 MM
Gorbein Oil		3 (s)	6,700 - 9,400		3													3	
Gulf Refining and Marketing		11 (s)	8,600	1972 - 1974	9		4			4							13		
Hercules Oil	12		8,800	1967 - 1978				24		12	12					24			
Husky Oil		2 (s)	9,000	1978				2								2			
Husky Oil		1 (b)	4,000	1978				1										1	
Keen Distributor		1 (s)	9,000	1978															
Keen Distributor		1 (b)	1,680	1964	1												4		
Kellam Distributor	2		8,000	1969 - 1971		2	2		2									3	
Kellam Distributor		3 (b)	2,000	1972 - 1977	3														
Kickapoo Oil		14 (s)	9,300	1972 - 1977				14		14				3	11			14	6.0 MM
Land O'Lakes, Incorporated		5 (s)	9,800	1977 - 1978				5		5		5					4	1	4.0 MM
Lehigh Oil		6 (s)	8,600 - 9,300	1975 - 1978	2			4						6		6			
Lerner Oil	8		8,700 - 9,000	1971 - 1977				16		16						16			
Marshall Oil		4 (s)	8,500	1968 - 1973				4		4						4			
M F A		19 (s)	8,500	1968 - 1978	19										19	1		18	
Mid Continent		6 (s)	9,000	1973 - 1977				6		6							6		
Miles Tank Lines	7	18 (s)		1965 - 1971	17		15		7		8	15			17		15	17	
Miller Oil		8 (s)	7,700 - 9,000	1972 - 1975	7		1				1	1			7	8			
Naph-Sol Refining		2 (s)	14,000	1975	2														
Oilfield Trucking	60		8,000	1968 - 1975				80		80			80			80			
Osage Oil and Transportation		5 (s)	8,500	1975				5											

Table 2-4. TANK VEHICLE SURVEY DATA (CONCLUDED)

Company	Quantity		Size Range (gallons)	Age Range (year)	Loading Technique[c]				Bottom Load Adaptor[c]			Secondary Automatic Shut-off[c]				Vapor Recovery System[c]			Annual Gasoline Throughput (gallons)
	Double Bottom Unit[a]	Single Unit[b]			Open Top	Submerged	Bottom	Top And Bottom	On Individual Line: V Valve	On Individual Line: Openable	On Manifold	Jet Level Sensor	Float Sensor	Dyna-probe	None	Individual Compartment	Manifolded	None	
Peerless Distributor		1-2 (s)	8,000 - 14,000	1968 - 1976				1-2										1-2	
Phillips Petroleum		150 (s)	9,000	1968 - 1978	135		15										17		
Rich Distributor		3 (s)	8,600 - 9,000	1972 - 1974	2		1			1			1				3		
Rockwood Oil		1 (s)	8,450	1966				1	1										
Rockwood Oil		1 (s)	8,600	1968				1	1										
Rockwood Oil		1 (s)	9,000	1978				1	1			1					1		
Smith Tank Lines	2	3 (f)	8,800 - 9,450	1958 - 1965	1		6										6	1	
Southern Fuel Distributor		1 (s)	8,450	1970	1													1	
Southern Fuel Distributor		1 (b)	1,800	1969	1													1	
Thomas Petroleum		66 (s)	8,000 - 9,250	1964 - 1978	46		20							20			20		
Transit Oil		4 (s)	9,000	1976			4							4			4		
V. B. Morgan	10		8,800		4		16										16		
Ventura Transfer	9		7,500	1954 - 1973				18		18					18			18	
Western Hyway Distributors	14		8,700	1973 - 1978				28			28				28		28		
Western Hyway Distributors		1 (s)	8,300	1965	1										1			1	
Western Marketing Distributors		1 (s)	8,200	1973				1										1	
Western Marketing Distributors		1 (s)	9,190	1977				1								1			
Wilding Transport	40		8,700 - 9,450	1964 - 1973	62			18		18			18				18	62	
Total	409	1,120	1,680 - 14,000	1954 - 1978	444	2	141	1,333	60	389	63	271	557	16	227	375	636	436	
Percent					23	.1	7	69	11.7	76.0	12.3	24.8	51.1	1.3	20.8	26	44	30	

[a] Double bottom unit can be either straight truck - full trailer or semitrailer - full trailer. Therefore, each unit will contain two tanks.

[b] (s) Semitrailer (f) Full trailer
(b) Bob tail (single unit straight truck)

[c] Numbers of tank indicated under the categories of Loading Technique, Bottom Load Adaptor, Secondary Automatic Shut-off, and Vapor Recovery System. The number in each category does not necessarily sum up to the total tanks in the company because some of the information was not given.

Table 2-5 shows the percentage of bottom loading tanks found in the survey as a function of company size. Most tanks in all categories as subdivided have bottom loading capabilities.

Table 2-5. TANKS WITH BOTTOM LOADING AND VAPOR RECOVERY AS A FUNCTION OF COMPANY SIZE[a]

Number of Tanks in Company	Total Tanks	Bottom Loading			Vapor Recovery		
		With	Without	Percent With	With	Without	Percent With
1 - 4	43	27	15	64	19	18	51
5 - 10	79	57	22	72	69	5	93
11 - 49	316	208	90	70	177	135	57
≥ 50	1,501	1,182	319	79	746	278	73
Total	1,939	1,474	446	77	1,011	436	70
Total Tank Basis[b]				76			52

[a] Data were not available for all tanks counted.

[b] Percentages assuming that tanks for which data were not available did not have bottom loading or vapor recovery capabilities.

2.5 ADDITIONAL SURVEY INPUT

2.5.1 VAPOR RECOVERY SYSTEMS

The overall survey value indicates that 70 percent of those tanks for which data were available had vapor recovery systems. Assuming that tanks for which data were not provided did not have vapor recovery capabilities, the overall percentage drops to 52 percent (Table 2-5).

2.5.2 BOTTOM LOADING ADAPTOR

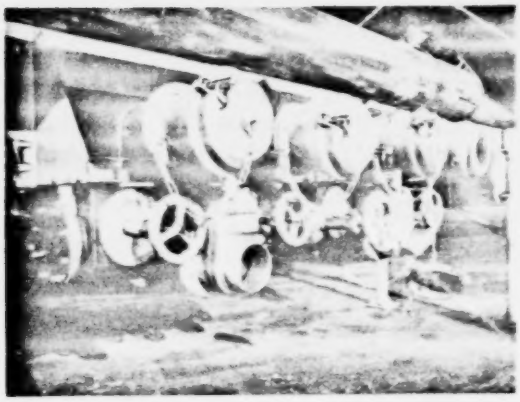
The three most common bottom loading discharge arrangements are shown on Figure 2-4. "Y" valves and openable adaptors are installed on the tank when individual compartment loading and unloading are required by the state. When the compartments are manifolded, API type and Buckeye adaptors are installed. The latter type of adaptor is only used on some old tanks and is not commonly found (Figure 2-5). As evidenced by Table 2-4, approximately 87.7 percent of tanks are equipped with individual lines for each compartment, and 12.3 percent with two or more compartments manifolded. The percentage of "Y" valves and openable adaptors installed on compartments with individual lines are 11.7 and 76.0. These percentages are based on 512 tanks for which this specific information was available.

2.5.3 SECONDARY AUTOMATIC SHUT-OFF DEVICES

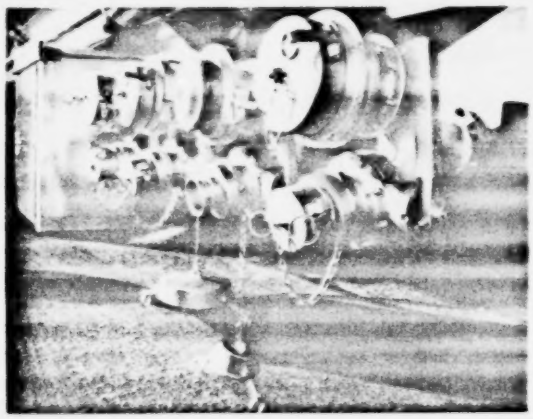
There were three secondary automatic shut-off devices found to be in use. These devices include the jet level sensor, float switch, and Dynaprobe. As estimated from the survey (Table 2-4), approximately 24.8 percent of tanks were reported to have jet level sensors, 51.1 percent to have float switches, and 3.3 percent to have Dynaprobes. These percentages are based on 1,091 tanks for which this specific information was available.

From comments received from the API and Fruehauf Corporation,[11,12] the percentage of jet level sensors in use appeared excessive. A review of the survey data showed that one large tank operator used jet level sensors exclusively and may have skewed the results. Further, the API[11] feels that less than 10 percent of tanks use jet level sensors. Furthermore, Fruehauf has experienced more interest in Dynaprobes and fiber optic systems than jet level sensors.[12]

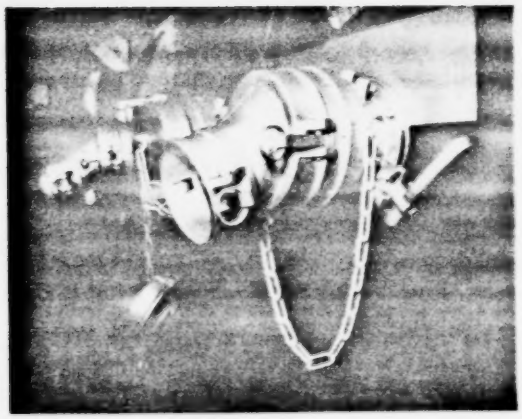
BOTTOM LOADING DISCHARGE ARRANGEMENTS



BOTTOM LOAD ADAPTORS
ON MANIFOLD



"Y" VALVES ON
INDIVIDUAL LINES

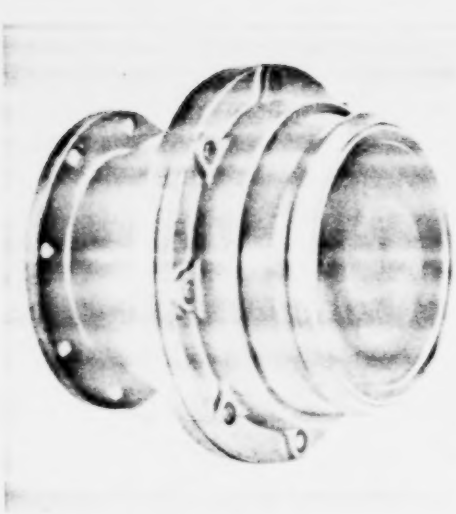


OPENABLE ADAPTORS ON
INDIVIDUAL LINES

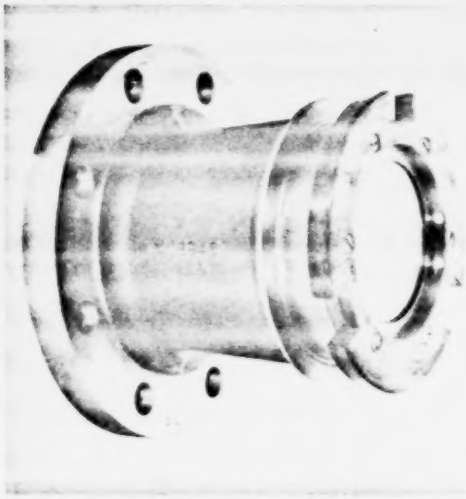
COURTESY
THE HEIL CO.

Figure 2-4. Bottom Loading Discharge Arrangements

BOTTOM LOAD ADAPTORS

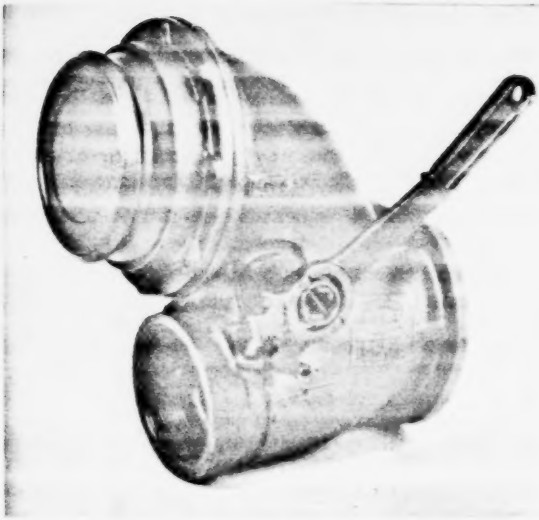


API TYPE

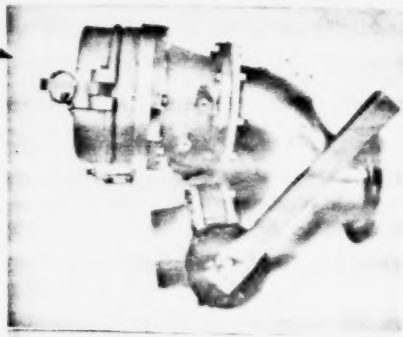


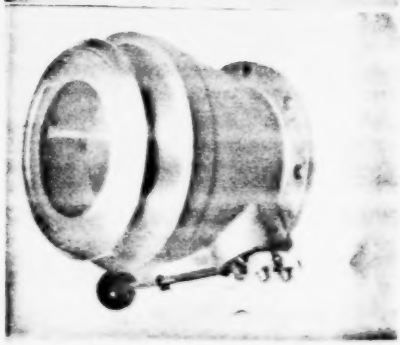
BUCKEYE 3 SLOT

BETTS "Y" VALVE



EMCO WHEATON "Y" VALVE





CARTER OPENABLE

COURTESY
THE HEIL CO.

Figure 2-5. Bottom Load Adaptors

3.0 VAPOR RECOVERY SYSTEMS

PES conducted a telephone survey which included over 1,900 tanks owned by tank vehicle operators throughout the United States. Vapor recovery information was obtained for 1,446 tanks. Of these tanks, 70.5 percent were indicated to be fitted with vapor recovery systems. Assuming that those tanks without vapor recovery information did not contain a recovery system, over half the surveyed tanks would still have capability for vapor recovery. Thus, there are indications that a significant number of tanks have been retrofitted with vapor recovery capability.

3.1 TYPES OF VAPOR RECOVERY SYSTEMS

Four possible arrangements are described for the installation of vapor recovery systems on tank trucks.[13] Each of the vapor recovery systems is described in subsequent paragraphs.

The first arrangement consists of vapor recovery hoods equipped with vapor lines. They are usually manifolded to the right side of the overturn rail. A flange connection is installed on either end of the rail for connnection to the vapor collector. In the most common arrangement, the connection to the vapor collection line is at the rear of the tank. Other possible connections to vapor collectors can be made at the bottom of the tank. This requires a vapor line with a flange connection which runs through the tank from top to bottom (Figure 3-1).

The second arrangement is generally applied to tanks with single- or double-wall flashings. They are not completely welded at their attachment points. A 4 inch, or a U-shaped 3 inch vapor line is connected to the vapor recovery hood and is manifolded by a 4 inch pipe. The 4 inch pipe terminates at the rear of the tank with a vent valve and a vapor recovery valve. These valves are interlocked with one valve open, the other closed (Figure 3-2).

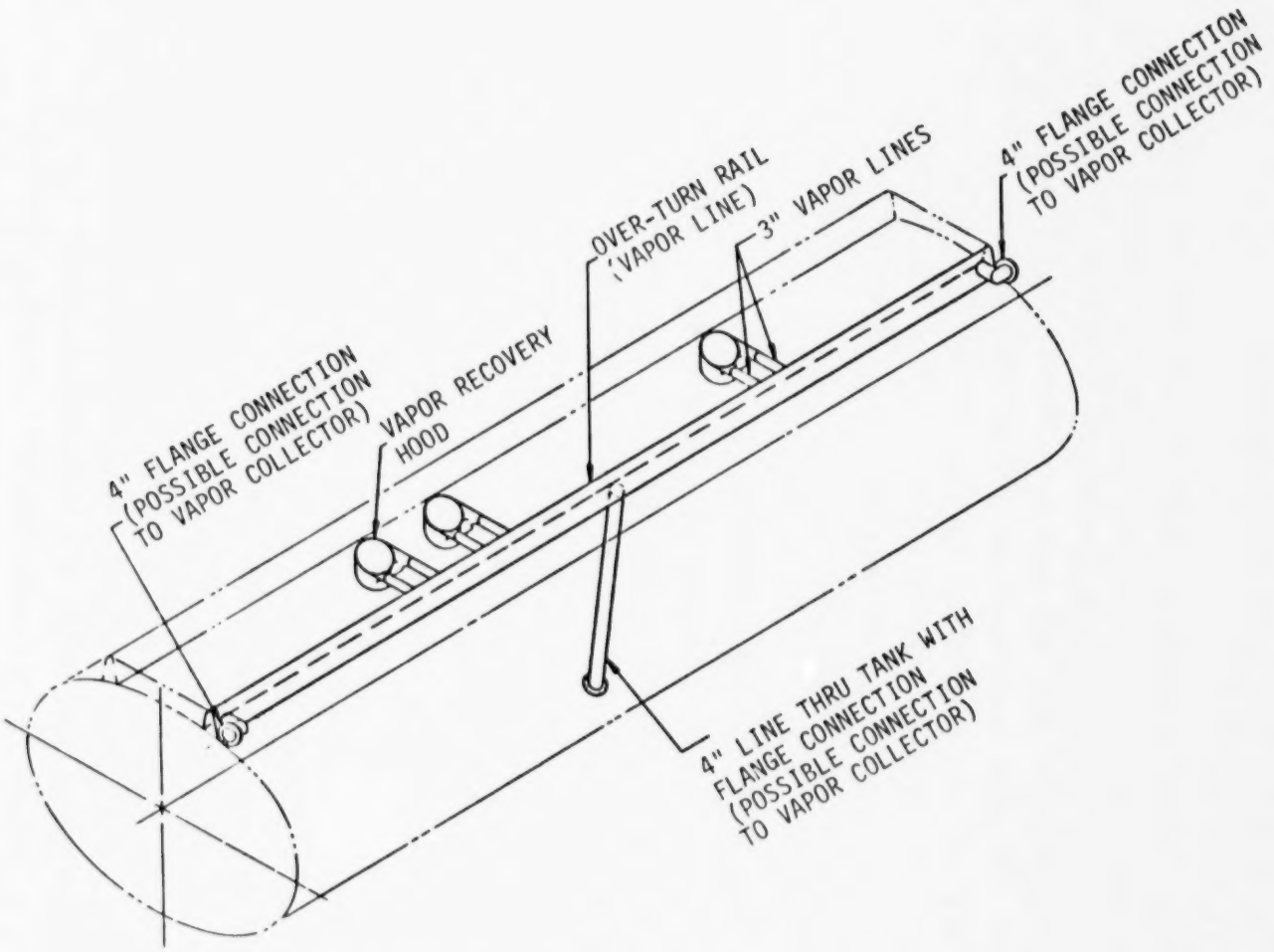


Figure 3-1. Vapor Recovery System Using Overturn Rail

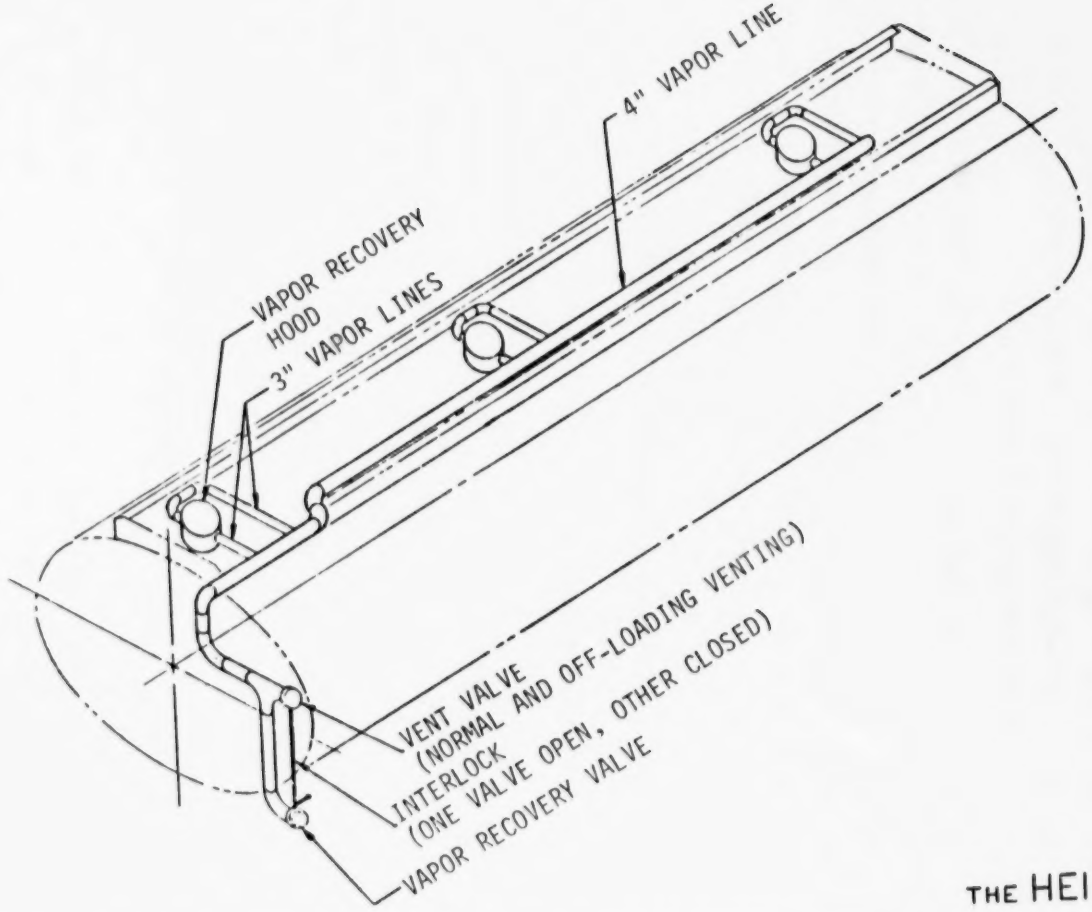

4" VAPOR LINE
VAPOR RECOVERY HOOD
3" VAPOR LINES
VENT VALVE (NORMAL AND OFF-LOADING VENTING)
INTERLOCK (ONE VALVE OPEN, OTHER CLOSED)
VAPOR RECOVERY VALVE
THE HEIL CO ©

Figure 3-2. Vapor Recovery System, Overturn Rail Cannot Be Used as Vapor Conduit

The third arrangement employs both sides of the turnover rail as manifolded vapor lines. A channel ring around the tank is connected to the rails, and a flange connection is installed at the bottom. The flange connection connects to the vapor collector during loading operations (Figure 3-3).

The fourth arrangement also utilizes both sides of the rail as vapor lines. The vapor from each compartment is manifolded into the vapor collection compartment. This compartment is located at the rear of the tank. The vapor collection compartment is equipped with a vent on the top for normal venting and off-loading. A vapor recovery valve at the bottom connects to a vapor collector (Figure 3-4).

3.2 REQUIREMENTS FOR VAPOR RECOVERY SYSTEMS

3.2.1 EXISTING TANKS WITHOUT PROVISIONS FOR VAPOR RECOVERY

The equipment required for retrofitting the tank vehicle with vapor recovery depends on the existing tank equipment. If auxiliary vents are present, a vapor recovery hood is installed on each vent to recover vapor. If no vents are available or the existing vent does not meet requirements, then new vents are added. Vapor lines are connected to hoods and manifolded to turnover rails, or a separate tube is laid along the top of the tank, as shown in Figure 3-2. This main vapor collection pipe is routed along the curb side and terminates in a suitable coupling. The coupling must be closed or covered when not in use.

Recommended practices for bottom loading and vapor recovery for gasoline tank vehicles are provided by the American Petroleum Institute in their bulletin "Bottom Loading and Vapor Recovery for MC-306 Tank Motor Vehicles" (API RP 1004).[14]

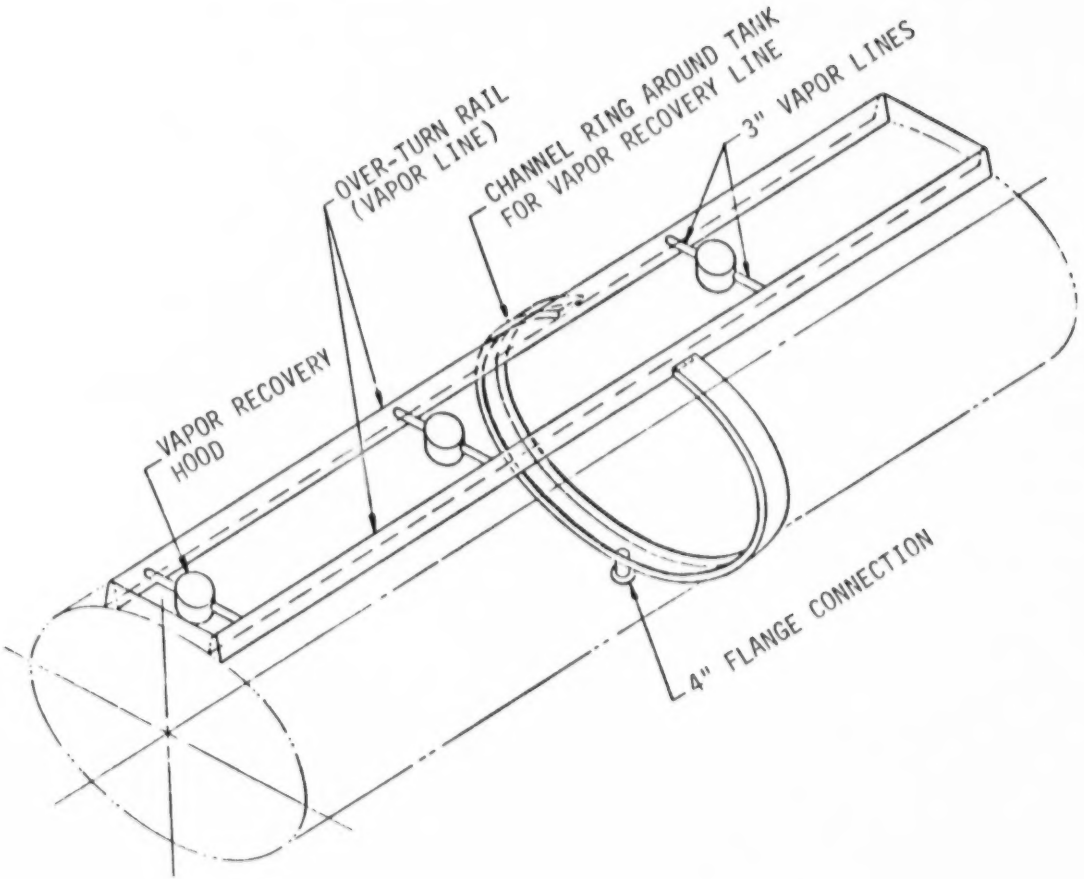


Figure 3-3. Vapor Recovery System, Channel Ring

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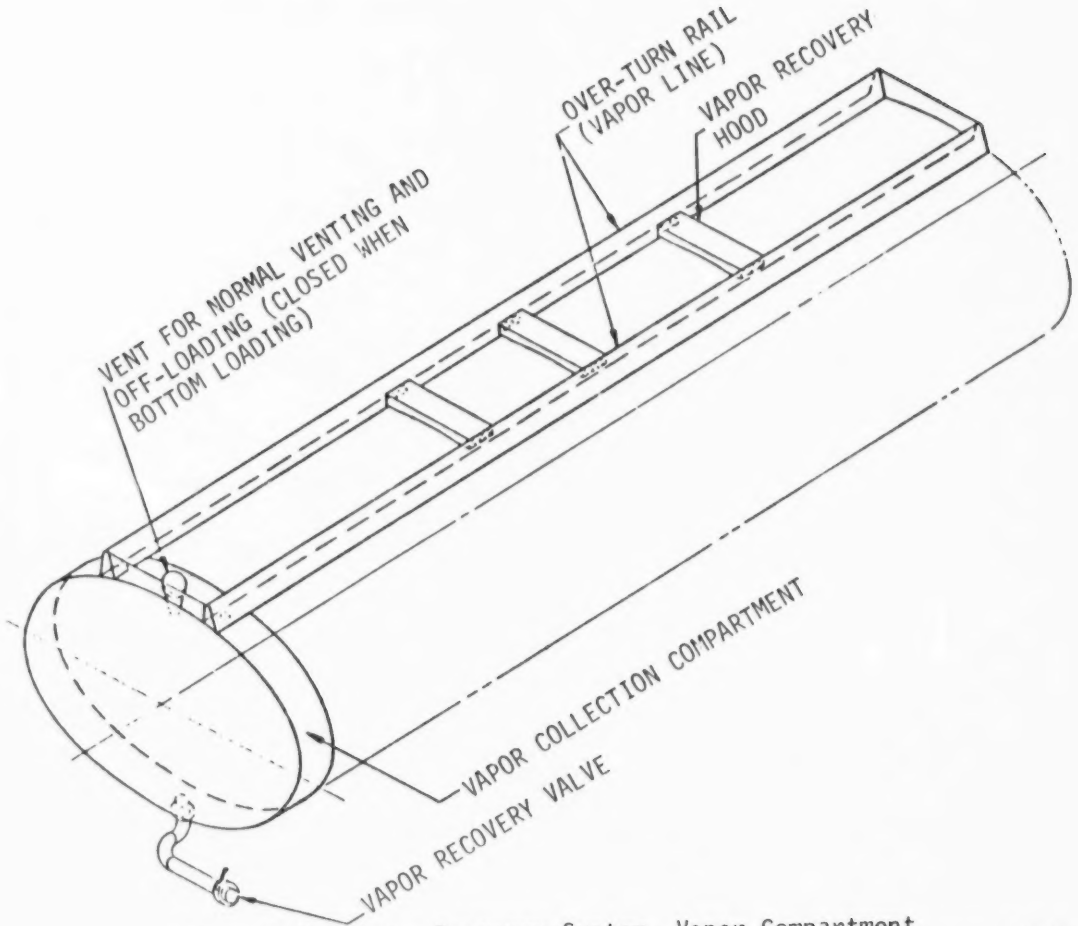

Figure 3-4. Vapor Recovery System, Vapor Compartment

THE HEIL CO

Most pre-1967 tanks require replacement of the old manhole cover by a current spring-loaded cover. These old covers are adjusted by the use of shims and are not generally leak tight. This requirement may create the need to enlarge the manhole to accept current manhole cover assemblies. Some older tanks do not have internal or emergency valves installed, or the configuration is such that the installation of this internal valve is difficult and time-consuming. These and other considerations make it more expensive to retrofit many pre-1967 tanks than tanks built more recently.

3.2.2 TANKS WITH RETROFIT PROVISIONS

Currently, most new tank vehicles delivered for gasoline use include provisions for bottom loading and vapor recovery. These include the installation of pilots and mounting brackets to facilitate the future installation of internal valves and secondary automatic shut-off devices. Blanked off ports are provided in the manhole covers and the overturn rail for easy addition of vapor hoods and piping. The liquid line is also blanked off for the future installation of loading adaptors. In effect, no welding or cutting of the tank will be required to retrofit newer tanks. As a result, the tank is easily and economically converted to bottom loading with vapor recovery systems and secondary automatic shut-off devices.

3.3 RETROFIT CONSIDERATION

Many factors are considered when a decision is made as to whether or not modification of equipment on an existing tank is the effective and economical way to meet requirements for gasoline marketing operations. Key factors in determining the economic advantages for purchasing a new tank are age and condition of the existing tank with respect to performance, safety, and repair costs.

4.0 COST ESTIMATES FOR TANK RETROFIT

4.1 CAPITAL COSTS

Equipment costs from the major tank truck equipment manufacturers are listed in Table 4-1. These costs are current listed prices. A certain percentage discount is generally given to oil companies, tank truck manufacturers, and carriers.

Associated labor costs for retrofitting the vehicle with bottom loading, vapor recovery system, and liquid level sensor are identified in Table 4-2 as a percentage of equipment cost.

Costs to convert existing top loading (open top) tanks to bottom loading with a vapor recovery system and secondary automatic shut-off depend on the construction of the tank and the type of components being installed. Both labor costs and the necessary equipment can be influenced by the tank construction. Some older tanks require extensive modification. Newer tanks, some fabricated up to 4 years ago, have provisions preinstalled to permit conversion to bottom loading and vapor recovery without welding or cutting.

Cost ranges for specific conversions are given in Table 4-3. Typical retrofit costs per compartment as a function of the age of the tank are presented in Table 4-4. Retrofitting cost differences between tank trucks and trailers are not significant.

4.2 MAINTENANCE COSTS

Maintenance costs for vapor recovery equipment are estimated by the National Tank Truck Carriers, Inc., to be nearly $500 per year for each tank. This value is estimated to be nearly 9 percent higher than the maintenance cost for tanks without vapor recovery equipment.[15]

Table 4-1. MANUFACTURER'S PRICE FOR TANK RETROFIT EQUIPMENT[a]

FOR BOTTOM LOADING

Equipment	1978 Cost ($)
Float Switch Controls	
With fixed shut-off level	53.40 - 79.50
With adjustable shut-off level	58.97 - 79.55
Vapor Vents	
Air actuated 3 inch	145.39 - 146.55
Air actuated 5 inch	303.65
Mechanically operated 3 inch	131.66 - 145.45
Mechanically operated 5 inch	187.25 - 204.90
Internal (Emergency) Valve	
Air actuated	87.35
Mechanically operated	80.55
Adaptors	
"Y" Valve	300.00 - 450.00
Openable	202.20 - 249.23
Adaptor on manifold	97.75 - 123.50
Pressure Actuated Manhole Cover	75.00

FOR VAPOR RECOVERY

Equipment	1978 Cost ($)
Vapor Recovery Hood, P-V Vent and Vapor Recovery Lines	250.00
Drybreak	150.00

[a] Sources: OPW, Emco Wheaton, Parker Hannifin

Table 4-2. INSTALLATION LABOR COSTS ESTIMATED AS A PERCENTAGE OF PURCHASED EQUIPMENT COST

Conversion	Percent of Equipment Cost
Top load (open top) to Bottom load Vapor recovery system Liquid level sensor	40 - 50
Top load (open top) to Bottom load only	30
Top load (open top) to Top Tight Submerged fill	30
Installation of vapor recovery system (tank equipped with air/mechanically operated emergency valve)	30
Installation of emergency valves	30

Source(s): Ruan Trucking Company, Des Moines, Iowa
Smith Tank & Equipment, Waco, Texas
Reliable Tank Company, Waco, Texas

The Heil Company, Wisconsin, estimates costs of $200 to $300 every 2 years for seal and gasket replacement and an additional $200 or more to replace internal valves and manholes in 8 to 10 years.[13] This could result in annual replacement costs of approximately $600 to $700. Since vapor recovery systems have not been used extensively for a sufficient duration, users of tanks equipped with vapor recovery were reluctant to provide estimates of maintenance costs.

Table 4-3. COST RANGES FOR SPECIFIED TANK CONVERSIONS

Conversion	Dollars Per Compartment (includes Labor)	
	(Tank Manufacturers)[a]	(Tank Operators)
Open top to bottom load, vapor recovery, automatic shut-off	900 - 2,000	800 - 2,000[b]
Open top to top tight submerged fill with vapor recovery	700 - 750	-
Open top to bottom load only	300 - 400	420[c]
Installation of vapor recovery system	450 - 750	320[c]
Installation of liquid level sensor (automatic shut-off)	60 - 200	138[c]

[a] Sources: J&L Tank, Weld-It, Clough Incorporated, Heil Company, Fruehauf Corporation, Smith Tool and Equipment, Emco Wheaton, Reliable Tank Company, Onnen Tank and Trailer, C&W Equipment.

[b] Sources: Western Marketing, Incorporated; Southern Fuel Distributors; Continental Oil; Rich Distributors; Rockwood Oil; Mid Continent; Ruan Trucking.

[c] Source: Ruan Trucking, Des Moines, Iowa

Table 4-4. TYPICAL COSTS TO RETROFIT TANKS OF DIFFERENT AGE GROUPS WITH BOTTOM LOADING AND VAPOR RECOVERY

A g e	Equipment Cost	Percent Added for Labor	Total Cost per Compartment
Pre - 1967	$1,160[a]	50	$1,740
1967 - 1975	1,085[b]	40	1,520
1976 - 1978	445[c]	30	580

[a] Equipment includes an adjustable shut-off level float switch, 5 inch air-actuated vent, Y valve, manhole cover and internal valve replacement, vapor recovery hood, P-V vent and vapor recovery lines. Add drybreak at $150 per tank.

[b] Equipment includes an adjustable shut-off level float switch, 5 inch air-actuated vent, air-actuated internal valve, Y valve, vapor recovery hood, P-V vents, and vapor recovery lines. Add drybreak at $150 per tank.

[c] Equipment includes an adjustable shut-off level float switch, Y valve, and vapor lines. Add drybreak at $150 per tank.

5.0 REFERENCES

1. "The 1978-1979 Tank Trucking Industry Market Report," Modern Bulk Transporter, Sutherland Publications, Inc., Washington, D.C.

2. U.S. Department of Commerce, Bureau of Census "1972 Census of Wholesale Trade, Methods of Receiving Bulk Liquid Products"

3. "Media and Market Fact File," Modern Bulk Transporter, Sutherland Publications, Inc., Washington, D.C.

4. "Petroleum Handling Systems and Components," Parker Hannifin, Irvine, California, 1973

5. Personal communication with Guinan, Ms. D.K., Association of American Railroads, Washington, D.C., October 1978

6. "Estimated Total Trailers in Use by Body Type," by Commercial Car Journal, June 1978

7. Personal communication with Richard J. McCarthy, Arthur D. Little, Inc., Cambridge, Massachusetts, October 1978

8. Personal communication with Dave Fellows, Heil Company, Milwaukee, Wisconsin, October 1978

9. National Petroleum News, Factbook Issue, June 1978

10. "The 1974-1975 Tank Trucking Industry Market Report," Modern Bulk Transporter, Sutherland Publications, Inc., Washington D.C.

11. Miller, W.M., American Petroleum Institute, Letter to S.A. Shedd of EPA, January 9, 1979

12. Botkin, L.A., Fruehauf Corporation, Letter to R.T. Walsh of EPA, December 22, 1978

13. Personal communication with Ken Williams, Heil Company, Milwaukee Wisconsin, October 1978

14. American Petroleum Institute, "Bottom Loading and Vapor Recovery for MC-306 Tank Motor Vehicles" (API RP 1004) Fourth ed., Washington, D.C., September 1977

15. Personal communication with Albert B. Rosenbaum III, National Tank Truck Carriers, Inc., September 1978

APPENDIX

Table A-1. TRUCK TRAILER TANK SHIPMENTS[a]

Year	Flammable Liquids	Total Tanks
1977	3,099	8,766
1976	4,316	6,556
1975	3,093	4,875
1974	4,450	8,610
1973	3,041	6,211
1972	2,743	5,341
1971	2,572	4,736
1970	2,487	4,537
1969	2,757	5,114
1968	2,210	4,862
1967	2,927	7,197
1966	3,379	6,481
1965	2,936	5,359
1964	2,548	4,755
1963	3,452	5,777
1962	2,855	5,463
1961	2,639	4,855
1960	3,470	5,694
1959	4,542	6,976
1958	3,942	5,624
1957	4,610	6,354
1956	5,511	6,584
1955	5,125	5,843

[a] From tables compiled by Truck Trailer Manufacturers Association, Washington, D. C. (Original source: current industrial reports of U.S. Bureau of Census).

Table A-2. TANK VEHICLE SURVEY, PETROLEUM TANK TRUCKS OR COMBINATIONS[a]

Code	State	(Year of Manufacture) 1941-1960	1961-1963	1964-1966	1967-1969	1970-1972	Totals
1	Alabama	7	5	18	19	21	70
2	Alaska	24	6	19	31	23	103
4	Arizona	10	7	7	6	8	38
5	Arkansas	3	3	10	22	21	59
6	California	34	14	12	25	9	94
8	Colorado	12	16	10	12	8	58
9	Connecticut	16	18	30	44	31	139
10	Delaware	10	12	11	22	20	75
11	Washington, D.C.	0	2	5	7	9	23
12	Florida	7	12	22	21	26	88
13	Georgia	7	14	16	30	27	94
15	Hawaii	26	4	3	10	6	49
16	Idaho	20	10	11	18	13	72
17	Illinois	10	16	22	38	27	113
18	Indiana	7	6	20	19	11	63
19	Iowa	17	7	21	42	27	114
20	Kansas	10	2	16	22	19	69
21	Kentucky	5	4	16	21	20	66
22	Louisiana	4	7	14	28	24	77
23	Maine	10	16	36	61	61	184
24	Maryland	11	9	16	14	12	62
25	Massachusetts	23	11	32	40	26	132
26	Michigan	4	6	8	21	25	64
27	Minnesota	28	11	18	42	45	144
28	Mississippi	6	6	17	30	21	80
29	Missouri	9	7	13	10	17	56
30	Montana	10	6	6	13	15	50
31	Nebraska	17	10	30	43	45	145
32	Nevada	31	6	11	8	8	64
33	New Hampshire	11	22	40	57	34	164
34	New Jersey	13	17	24	25	34	113
35	New Mexico	9	9	16	18	22	74
36	New York	31	24	31	52	48	186
37	North Carolina	10	15	30	50	37	142
38	North Dakota	7	3	5	19	4	38
39	Ohio	6	6	19	19	25	75
40	Oklahoma	12	12	23	26	25	98
41	Oregon	27	7	18	15	19	86
42	Pennsylvania	25	16	16	38	24	119
44	Rhode Island	35	27	35	41	30	168
45	South Carolina	16	12	28	30	21	107
46	South Dakota	9	10	15	22	17	73
47	Tennessee	3	5	17	25	33	83
48	Texas	18	18	26	51	52	165
49	Utah	17	11	15	20	22	85
50	Vermont	3	3	26	39	38	109
51	Virginia	6	7	19	26	27	85
53	Washington	14	4	7	7	4	36
54	West Virginia	10	14	13	17	14	68
55	Wisconsin	6	12	27	33	33	111
56	Wyoming	26	17	15	22	25	105
	Totals	692	524	935	1,371	1,213	4,735

[a] 1972 Census of Transportation Truck Inventory and Use Survey, U.S. Department of Commerce, Bureau of Census, 1973. Data retrieved for petroleum or petroleum products.

Table A-3. ESTIMATE OF NUMBERS OF VEHICLES IN AGE CATEGORIES

	Tank Data	
	Year Built	Number
Vehicles surveyed by Census Bureau (petroleum products handling)	Pre-1967 1967 - 1972 Total	2,151 2,584 4,735
Adjusted total for 1972 (basis 75,000 tanks in flammable liquid service in 1972)	Pre-1967 1967 - 1972 total	34,070 40,930 75,000
Corrected for assumed depletion to 1977 20 percent 10 percent	Pre-1967 1967 - 1972 total	27,300 36,800 64,100
1977 estimated total tanks Tanks accounted for to 1972 Balance		97,800 64,100 33,700
Estimated using direct ratios of tank trailer shipment data for the relevant years	1973 - 1975 1976 - 1977	19,800 13,900